Space Weather Technical Forecast

Issued on Wednesday, 31 May 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of isolated R1/R2 radio blackouts throughout. Increasing chance of Active electron fluence into the period. Slight chance of isolated G1/Minor storm intervals Day 2 onwards.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24hrs with three M1 flares from AR3310, which is now behind the southwest limb. There are currently 10 numbered sunspot regions on the visible disc and 2 unnumbered regions. AR3315 (Eko/Beta-Delta-Gamma) remains the largest region and most magnetically complex, with a small delta spot within its trailing group. AR3319 also has some magnetic complexity, and is currently classified as a Dai/beta-gamma having developed over the past 24 hours. The remaining regions have been either stable, or with only small amounts of change, and are all smaller and magnetically weaker. No Earth-directed CMEs were observed on available imagery during the period.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have remained at generally ambient levels 350-400 km/s. Density has been below average (<5 ppcc). The total interplanetary magnetic field strength has been weak, at or below 7 nT. The north-south component has weakly fluctuated between +7/-5 nT but predominantly positive from 29/1800UTC. The phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV at GOES-16) has remained at background levels throughout. High energy electron flux (greater than 2MeV at GOES-16) also remained at background to moderate levels. The associated 24 hour fluence has been below Active (above 1e8 integrated pfu), but with a steadily rising trend. Electron fluence observed at 31/0000UTC was 1.7e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Moderate. A chance of isolated M-class flares and an ongoing slight chance of an X-class flare is maintained throughout the period, although the probabilities of significant flares occurring may increase late in the forecast period as new or returning regions are expected to rotate onto the visible disc.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently forecast but there is potential of a glancing blow from a CME (that left the Sun on 26 May) either today or tomorrow. Solar winds are likely to be remain ambient or slightly elevated levels, perhaps becoming elevated Day 2 onwards (1 June). This is due to a HSS from coronal hole CH08/+ , and a possible CIR ahead of it. Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp 1-3) with a chance of Active (Kp 4) intervals, and a slight chance G1/Minor Storms (Kp 5). Firstly due to possible CME impacts today (31 May), followed by potential connection to either a CIR and/or HSS from CH08/+ from tomorrow (1 Jun).

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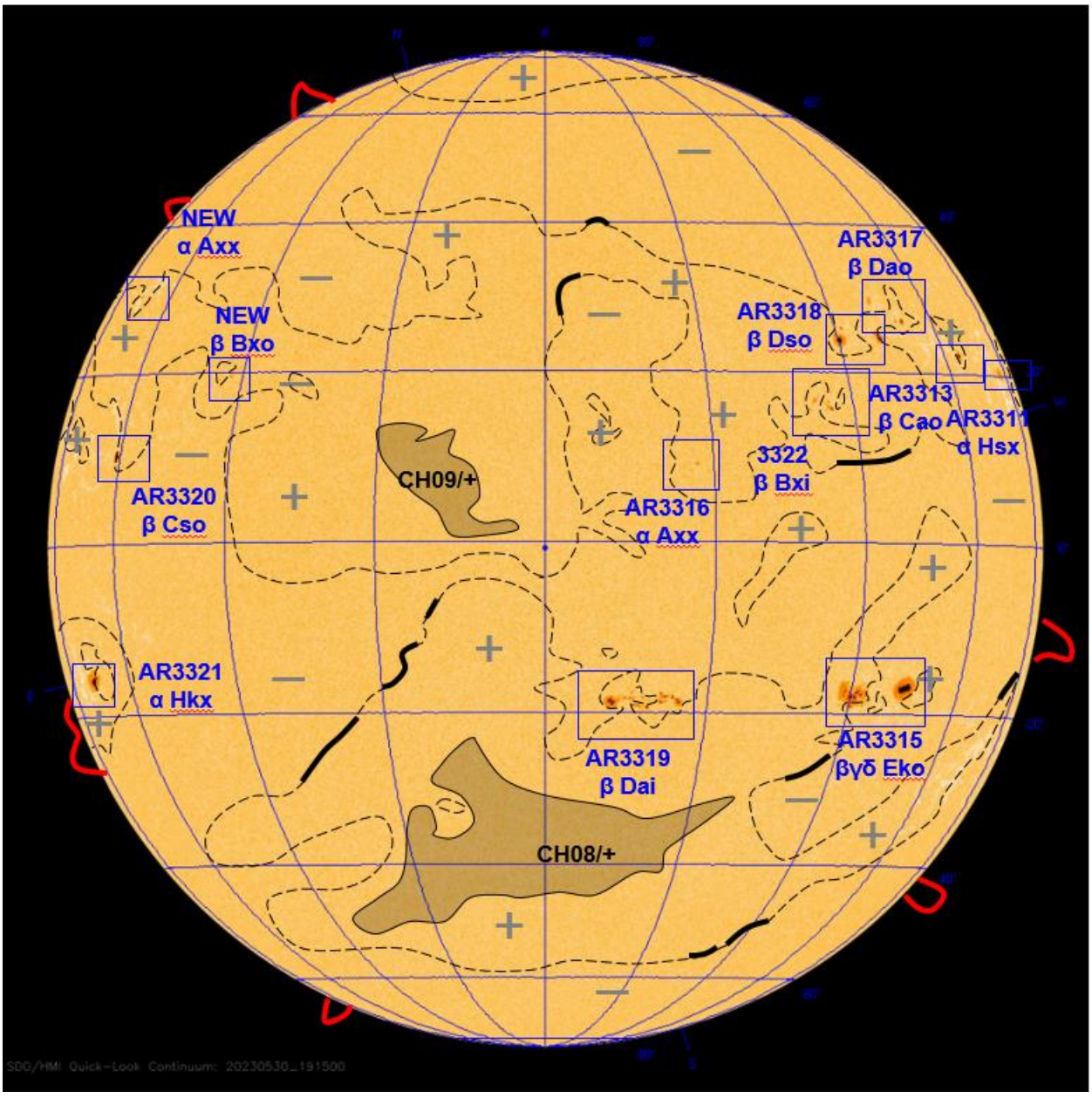
Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background levels, however there remains a slight chance of reaching the S1/Minor Storm threshold should any larger flares occur. High energy electron flux (greater than 2MeV) is expected to remain largely below the high threshold but with an increasing chance of reaching High levels during the diurnal maximum. This leads to an increasing chance that Electron fluence values may breach the Active (1e8 integrated pfu) threshold through the period, but there is low confidence due to uncertainty of modifying factors and poor model guidance.

Figure 1. Solar Analysis Valid 30/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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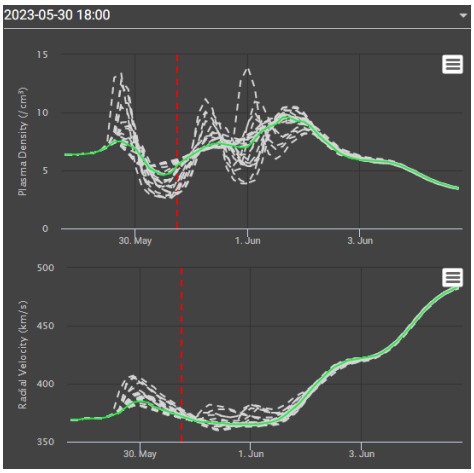
Geomagnetic Storms:

No Earth-directed CMEs have been observed on available imagery over the past 24-hours. However, a number of Enlil ensemble members support a glancing blow, today or tomorrow (see Figure 2), from a CME that left the Sun on 26 May, although much of this feature is directed southward.
Solar winds are likely to be remain ambient or slightly elevated levels. A HSS from coronal hole CH08/+ in the south of the disc, and a possible CIR ahead of it, is expected to influence conditions from late tomorrow onwards. Persistence would suggest that the high speed stream may result in peak speeds of around 500km/s, although currently ENLIL forecast output suggest that the bulk of this HSS will pass to the south of the Earth.
Geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp 1-3) with a chance of Active (Kp 4) intervals, and a slight chance G1/Minor Storms (Kp 5). Firstly due to possible CME impacts today (31 May), followed by potential connection to either a CIR and/or HSS from CH08/+ from tomorrow (1 Jun).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	20	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Ensemble forecasts



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Radio Blackouts - X-Ray Flares:

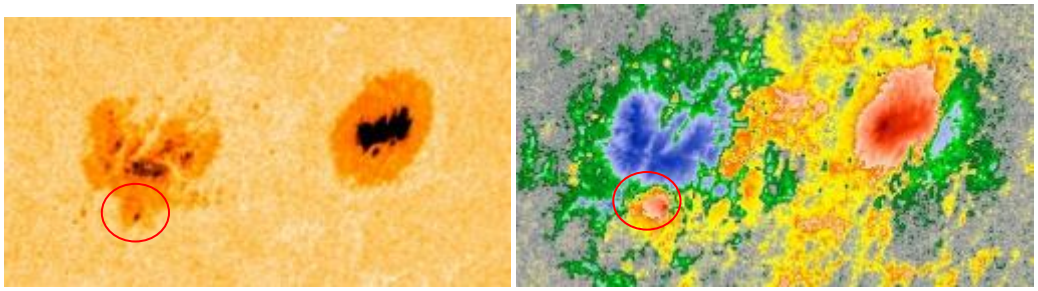
Solar activity has been Moderate over the last 24hrs with three M1 flares, peaking at 30/1022UTC at M1.3, all from the departing AR3310 on the southwest limb.

There are currently 10 numbered sunspot regions on the visible disc and 2 unnumbered regions. AR3315 (Eko/Beta-Delta-Gamma) remains the largest region, despite continuing to simplify slightly, with a very small delta spot remaining visible within its trailing group. AR3310 (Hsx/Alpha) passed beyond the western limb, but remains active. AR3319 (Dai/Beta-gamma) in the southwest continued to see some growth. The other numbered regions saw only small changes in recent hours.

Due to the complex nature of some of the active and developing regions, a chance of further isolated M-class flares and an ongoing slight chance of an X-class flare is maintained through the period. However, the probabilities of significant flares occurring may increase late in the forecast period as several regions, some of which may have been responsible for significant activity as they tracked across the far-side, are due to rotate onto the eastern limb towards the end of the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: AR3315 with delta spot. SDO AIA intensitygram (left) and magnetogram (right).



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and expected to remain so. A slight chance of S1/Minor Radiation Storming is maintained should any larger flares occur. AR3315 remains the most likely source region in the near term as it continues to transit the southwestern hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at Background to Moderate levels. Through the period it is increasingly likely to reach High levels during the diurnal maximum in the absence of any modifying factors, particularly later in the forecast. The most likely source of any geomagnetic activity is from a CME arrival today or tomorrow, although this is expected to largely pass below the Earth, resulting in limited geomagnetic activity. There is a chance that a coronal hole HSS may connect at Earth from tomorrow onwards (1st June) which may act to suppress the observed flux levels.

The associated 24 hour fluence is expected to show a rising trend, and therefore an increasing chance of breaching the Active (1e8 integrated pfu) threshold in the absence of significant geomagnetic activity. The REFM initially shows a rising trend, followed by a decline in fluence levels during days 2 and 3. Therefore the model is considered not to be offering good guidance from tomorrow onwards.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	20	30	40	50
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Met Office REFM model.

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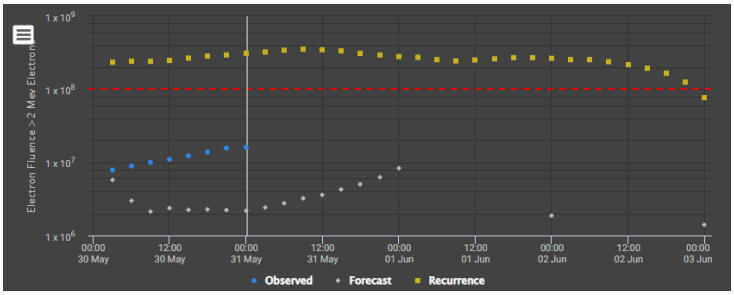

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